Tutorial -7 gas mixture and psychrometry

1. A 100 m^3 storage tank with fuel gases is at 20°C, 100 kPa containing a mixture of acetylene C_2H_2, propane C_3H_8 and butane C_4H_{10}. A test shows the partial pressure of the C_2H_2 is 15 kPa and that of C_3H_8 is 65 kPa. How much mass is there of each component? Son12.2, Ans: c2h2 =16.024kg, c4h10 = 47.693kg

2. Three SSSF flows are mixed in an adiabatic chamber at 150 kPa. Flow one is 2 kg/s of O_2 at 340 K, flow two is 4 kg/s of N_2 at 280 K and flow three is 3 kg/s of CO_2 at 310 K. All flows are at 150 kPa the same as the total exit pressure. Find the exit temperature and the rate of entropy generation in the process. son12.14, Ans: 301.8 K, s_gen= 1.871 kw/K

3 . A piston/cylinder contains 0.5 kg argon and 0.5 kg hydrogen at 300 K, 100 kPa. The mixture is compressed in an adiabatic process to 400 kPa by an external force on the piston. Find the final temperature, the work and the heat transfer in the process. Assume rev adiabatic process. Son 12.16 Ans: 451K, w12=-784.9 kj

4. A mixture of 2 kg oxygen and 2 kg of argon is in an insulated piston cylinder arrangement at 100 kPa, 300 K. The piston now compresses the mixture to half its initial volume. Find the final pressure, temperature and the piston work. C.V. Mixture. Control mass, boundary work and no Q, assume reversible. Son12.23 Ans: p2=279 kpa, T2 =418 kpa, w12 =-231 kJ

5. Two insulated tanks A and B are connected by a valve. Tank A has a volume of 1 m^3 and initially contains argon at 300 kPa, 10°C. Tank B has a volume of 2 m^3 and initially contains ethane at 200 kPa, 50°C. The valve is opened and remains open until the resulting gas mixture comes to a uniform state. Determine the final pressure and temperature. Son 12.24 Ans: t2=315.5 k, p2= 242 kPa.

6. A spherical balloon has an initial diameter of 1 m and contains argon gas at 200 kPa, 40°C. The balloon is connected by a valve to a 500-L rigid tank containing carbon dioxide at 100 kPa, 100°C. The valve is opened, and eventually the balloon and tank reach a uniform state in which the pressure is 185 kPa. The balloon pressure is directly proportional to its diameter. Take the balloon and tank as a control volume, and calculate the final temperature and the heat transfer for the process. Son12.28, Ans: t2=361.3K, q=-2.4kJ

7. Consider 100 m^3 of atmospheric air at 100 kPa, 25°C, and 80% relative humidity. Assume this is brought into a basement room where it cools to 15°C, 100 kPa. How much liquid water will condense out? Son 12.39 Ans: 0.56 kg

8. A flow moist air at 100 kPa, 40°C, 40% relative humidity is cooled to 15°C in a constant pressure SSSF device. Find the humidity ratio of the inlet and the exit flow, and the heat transfer in the device per kg dry air. Son 12.42, Ans: q=43.54 kJ/kg-dry air

9. A steady supply of 1.0 m^3/s air at 25°C, 100 kPa, 50% relative humidity is needed to heat a building in the winter. The outdoor ambient is at 10°C, 100 kPa, 50% relative humidity. What are the required liquid water input and heat transfer rates for this purpose? Son 12.44, Ans: m_dot_water=.0071 kg/s, q_dot=34.76 kw

10. Consider a 500-L rigid tank containing an air–water vapor mixture at 100 kPa, 35°C, with a 70% relative humidity. The system is cooled until the water just begins to condense. Determine the final temperature in the tank and the heat transfer for the process. Son 12.45, Ans: t2=28.2C, q12 = -2.77 kJ

11. A rigid container, 10 m^3 in volume, contains moist air at 45°C, 100 kPa, $\phi = 40\%$. The container is now cooled to 5° C. N eglect the volume of any liquid that might be present and find the final mass of water vapor , final total pressure and the heat transfer. Son. 12.49, Ans: p2=86.12 kpa, mv2 = .0679 kg, q12= -754.4 kJ

12. A water-filled reactor of 1 m^3 is at 20 MPa, 360°C and located inside an insulated containment room of 100 m^3 that contains air at 100 kPa and 25°C. Due to a failure the reactor ruptures and the water fills the containment room. Find the final pressure. Son12.53, Ans 700kpa,